PREPRODUCTION INITIATIVE-NELP
POWDER COATING TOUCH-UP SYSTEM
TEST PLAN

SITE: PORTSMOUTH NAVAL SHIPYARD, PORTSMOUTH, NH

1.0 OBJECTIVE

The Navy is currently transitioning from conventional liquid paint to powder coating to protect submarine components from corrosion. Powder coating is the preferred method because it possesses advantages compared to liquid coatings, for example:

- Volatile organic compounds (VOCs) are at near-nondetectable limits.
- Heat curing the powder forms a more durable finish than that achieved with liquid paint.
- Powder coating provides a healthier work environment.

A potential difficulty exists in using the new powder coating method for small touch-up work. Liquid paint touch-up procedures require only a can and a paintbrush or paint gun, and possibly some minor surface preparation of the affected area. Because powder paint is applied using a large-scale manual process, minor touch-up repairs require that the entire piece of equipment be stripped and recoated. The purpose of the powder coating touch-up kit technology is to eliminate unnecessary stripping and recoating by refinishing only the damaged portions of the substrate.

This test plan describes data collection procedures for the powder coating touch-up kit and its components. The data will be used to determine the kit's efficiency, effectiveness, and overall success repairing small scratches and minor coating damage in an environmentally friendly manner. The kit is expected to:

- Simplify the powder coating repair process
- Minimize coating waste and dusts
- Minimize costs of consumables and waste disposal
- Provide a healthier work environment
- Increase the use of powder coating systems and improve corrosion resistance.

2.0 DESCRIPTION

Currently, Portsmouth Naval Shipyard completely strips and repaints submarine components and miscellaneous parts. The components are powder coated as needed (i.e., components are powder coated as the current conventional coating is damaged or in need of replacement). These components are typically steel; however, substrates such as aluminum and copper have also been powder coated. Since the powder coating process currently used at Portsmouth is intended for large areas, the entire piece must be stripped and recoated if a portion of a powder-coated component is damaged. The powder coating

touch-up kit will eliminate the need to strip and repaint the entire piece when minor damage occurs to the coating. Therefore, the site will save time and reduce overall costs because of improved efficiency, reduced man-hours, and reduced waste disposal.

2.1 EQUIPMENT DESCRIPTION

The powder coating touch-up kit includes the following equipment for surface preparation, powder coating application, heat curing, and coating inspection:

- The Nilfisk Double Action Sanding System (Model 4960 VA) for surface preparation—A vacuum-assisted sanding system that reduces the amount of particulate matter released into the environment during the coating removal process. The Nilfisk Electric Explosion Proof Wet/Dry Vacuum System (Model EXP 1-75) powers the sanding system tool and vacuums up waste generated during surface preparation and any powder residue after the powder coating has been applied. During the test period, this vacuum will be used to clean up only powder overspray and waste generated by the use of the powder coating touch-up kit. To simplify the data gathering procedures, the Nilfisk Model T60SF vacuum will not be used.

- The Nordson Versa Spray II Manual Powder Outfit for paint application—Consists of a dolly-mounted 50-pound hopper, a manual spray gun, and a power controller. To increase ease of operation and efficient coating usage, the manual spray gun has an automatic feedback current (AFC) control, which adjusts the electrostatic voltage output to maintain the optimal powder charge and external field strength, regardless of the distance between the gun and the substrate.

- The Eastwood Infrared Light Cure System (Part No. 10180) for heat curing—Consists of an infrared heater that can be either hand-held or stand-mounted. The system can cure large and small objects at various distances, positions, and temperatures for various lengths of time, depending on the size of the object.

- The Paint Inspector's Test Kit for proper and accurate testing of powder-coated equipment—Includes the following tools: EBAN3000(F) with measuring probe, Testex tape roll, burnishing tool, Testex snap gauge, calibration foils, steel zero plate, wet film gauge, digital thermometer, BS whirling hygrometer, dew point and relative humidity % (RH%) slide calculator, and ISO surface roughness comparator (see Appendix). These tools are used to collect data when testing for different parameters and to assist the operator in making decisions/adjustments when applying the powder coating. Note that although it is included in this test kit, the wet film gauge is not applicable to powder coating operations. Therefore, no measurements will be taken with this instrument.

3.0 TEST PLAN

This test plan will evaluate the effectiveness of the powder coating touch-up kit in reducing costs, man-hours, and waste.

3.1 Approach

The quantities of powder coating material used and the waste generated during the course of this test period will be calculated based on averages determined at the start of the test period (see Table 1). In addition, quantitative and qualitative data will be acquired through the completion of Tables 2 and 3.

3.1.1 Determination of Average Powder Used and Waste Generated (Table 1, Initial Information Data Sheet)

To determine the average quantity of powder used and the amount of waste generated using the touch up kit, the following procedure will be followed:

1. An unused filter bag for the electric explosion-proof vacuum will be weighed and the weight recorded in Table 1.

2. A 2-square-foot area of a coated substrate will be prepared using the vacuum-assisted sanders.

3. The filter bag containing the sanding waste from the electric explosion-proof vacuum will be weighed and the weight recorded in Table 1. The difference between this weight and the initial weight of the filter bag is the amount of waste generated during surface preparation.

4. The powder supply canister will be weighed and this weight recorded in Table 1. In addition, the color of the powder in the supply canister will be recorded in Table 1.

5. The prepared area will be coated with powder.

6. The powder supply canister will be weighed and the weight recorded in Table 1. The difference between this weight and the previous weight of the canister is the amount of powder applied to the surface.

7. Any overspray will be cleaned up using the appropriate attachment on the electric explosion-proof vacuum.

8. The filter bag for the electric explosion-proof vacuum will be weighed and the weight recorded in Table 1. The difference between this weight and the weight of the filter bag in Step 3 is the amount of overspray generated during the powder application operation.

Steps 1 to 8 will be repeated for the gray and green powders used at Portsmouth. If the area of 2 square feet is insufficient to provide a weighable difference between operations, an area of sufficient size should be used.

3.1.2 Instructions for Completing Table 2 (Powder Coating Data Sheet)

Table 2 should be completed for each submarine component or miscellaneous part that is **touched up**.

General Data

- **Date:** Indicate the date on which the powder coating touch-up equipment was used (month/day/year).
- **Operator(s):** Identify the individual(s) who performed the touch-up work.
- **Piece Coated:** Record the type of piece being touched up.
- **Surface Area of Touch-up:** Record the surface area touched up, including the area stripped and recoated. The touched-up surface area should be calculated in square inches. These data will be used to calculate the quantity of powder used during the touch-up process.
- **Surface Area of Entire Piece:** Record the approximate surface area of the entire piece. This area should be calculated in square feet. This data will be used to calculate the amount of waste that would have been generated if the entire piece were stripped and recoated.
- **Color Used for Touch-Up:** Record the color used to touch up the piece.
- **Equipment Used:** Check all equipment used during the entire touch-up process.

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Meter Readings (See the appendix for detailed descriptions of the individual tools included in this kit.)

- **Surface Profile:** Sanding equipment is used to obtain a surface profile that will allow the coating to properly adhere to the substrate. For the powder coating to achieve optimal adhesion, the surface of the piece must be prepared properly. The test equipment needed to determine the surface profile include the Testex tape roll, brushing tool, and Testex snap gauge. The surface profile number, which is measured in microns, should be recorded in Table 2. For proper use of this equipment, refer to pages 22 through 25 of the Paint Inspector's Test Kit operator manual.
- **Dew Point:** Before the coating is applied, it is necessary to ensure that the surface to be painted is dry and that moisture or dew does not form on the uncoated surface. The dew point is calculated in degrees Celsius by using the slide calculator and readings from the wet and dry bulbs of the whirling hygrometer. The air temperature also can be used as an alternative method when

calculating the dew point. Reference pages 19 through 21 of the Paint Inspector's Test Kit operator manual for proper instruction and record the results in Table 2.

- **Relative Humidity (RH%):** Water is usually linked to coating failure. Pure water in liquid form can chemically react to degrade the coating or the coating-substrate interface; this is also true for humidity. The first step when determining the RH% is to use the whirling hygrometer, apply the results to the RH% and dew point slide calculator, and record the result in Table 1. Reference pages 19 through 21 of the Paint Inspector's Test Kit operator manual for proper instruction.

- **Air Temperature:** Air temperature can also be used to determine the dew point. The digital thermometer can be used to take this reading in degrees Celsius. Record the result in Table 2.

- **Substrate Temperature:** If the substrate temperature is greater than the dew point, it will prevent moisture from condensing on the surface of the substrate during touch-up operations. The digital thermometer and the calibrating foil are used to measure the substrate temperature in degrees Celsius. Record the average substrate temperature in Table 2.

- **Dry Paint Film Thickness:** Dry paint film thickness (coating thickness) is considered the most important measurement. This parameter ensures that the appropriate quantity of coating material is applied to the substrate and is also a good control for monitoring the efficiency of the process. The equipment needed to perform this procedure include the EBAN3000(F) and the measuring probe. The EBAN3000(F) coating thickness meter measures film thickness and displays a number (in microns) that should be recorded on Table 2.

Operational Data

- **Surface Preparation Time:** Record the total time in minutes and/or hours that was required to properly prepare the affected surface.

- **Powder Coating Time:** Record the total time in minutes and/or hours that was required to perform touch-up recoating of the affected surface.

- **Heat Curing Time:** Record the total time in minutes and/or hours that was required to properly cure the touched-up area.

- **Heat Curing Temperature:** Record the temperature (ºC or ºF) used during the curing process with the Eastwood Infrared Light Cure System according to the gauge on the system. To provide effective and reproducible performance in all properties, the cure cycle is essential. The cure cycle can best be described by the amount of time the substrate is at a given cure temperature. Determining the appropriate cure temperature and time can be accomplished by using

manufacturers' charts that allow the operator to correctly select a cure temperature and time to ensure proper adhesion.

Comments

Describe in detail for each piece of equipment used during the powder coating touch up process the kit's effectiveness, capabilities, and any problems, praises, or constructive criticism. If additional space is necessary, please use the back of the data sheet or an additional piece of paper.

3.1.3 Instructions for Completing Table 3 (Calendar)

Repairs will be arranged through your PPEP POCs (Ken Wright and Chris Mahendra), not the vendor. Please call Ken Wright at (856) 667-6770 or Chris Mahendra at (732) 323-7131 if any repairs are required for the powder coating touch-up kit.

General Data

- **Month/Year:** List the month and year during which the data are being collected. One calendar must be submitted for each month during the test period.

Downtime

- **Equipment Usage:** For each day of the month, circle "yes" or "no" according to whether the powder coating touch-up equipment was used that day.

- **Reason for Downtime of the Equipment:** For each day of the month, circle whether the powder coating equipment was not used because it was under repair, being maintained, or because no workload was present that day. One of these three responses must be circled for each day of the month that the touch-up kit is not used. Also, an explanation regarding downtime due to repairs or maintenance must be recorded in the Comments section.

Waste Generated

The Nilfisk vacuums will be used to clean up only the sanding waste and the excess powder generated during touch-up operations. If one of the reusable filter bags needs to be emptied during the month, it must be weighed and the weight recorded before the material is disposed. In addition, the filter bag will be weighed, its weight recorded, and emptied on the last workday of each month.

Comments

Comments should focus on explaining any repairs, when and what maintenance was performed, and the amount of time spent on repairs or maintenance for each day

indicated. Also, comment on the condition of the filters (i.e., any noticeable damage, inability of the vacuum unit to filter properly, or everyday wear and tear on the filter).

4.0 REPORTING

The data entry forms are a concise method of data collection. Forms should be completed on a daily basis; data will be collected for approximately one year. At the start of the test period, copies of the initial information data sheet (Table 1) will be completed for each powder color and faxed to Ken Wright. During the test period, the powder coating data sheet (Table 2) and the calendar (Table 3) should be faxed at the end of each month to Ken Wright at (856) 667-7586. Any questions should be directed to his attention at (856) 667-6770 or to Chris Mahendra at (732) 323-7131. The final report will include detailed results and observations, assess the efficiency and cost-effectiveness of the unit, and evaluate its ability to interface with site operations.

TABLE 1
INITIAL INFORMATION DATA SHEET

At the start of the test period, please complete this sheet for each color of paint used during operations at NS Portsmouth.

Initial weight of filter bag (Step 1):_____

Size of area prepared (Step 2): 2 ft^2

Weight of filter bag after surface preparation (Step 3):_____

Initial weight of powder supply canister (Step 4):_____

Color of powder in supply canister (Step 4):_____

Weight of powder supply canister after coating operation (Step 6):_____

Weight of filter bag after coating operation cleanup (Step 8):_____

TABLE 2
POWDER COATING DATA SHEET
Please complete this sheet for each piece that is touched up using the kit.

Date:_____
Operator(s):_____
Piece Coated:_____

Surface Area of Touch-up (in^2):_____
Surface Area of Entire Piece (ft^2):_____
Color Used for Touch-up:_____

Equipment Used:

- ☐ Nilfisk Double-Action Sanding System
- ☐ Nilfisk Electric Explosion Proof Wet/Dry Vacuum
- ☐ Nordson Manual Powder Outfit
- ☐ Powder Coating Inspection Test Kit
- ☐ Eastwood Infrared Light Cure System

METER READINGS	
Readings	**Data**
Surface profile (microns)	
Dew point (°C)	
Relative humidity (RH%)	
Air temperature (°C)	
Substrate temperature (°C)	
Dry paint film thickness (microns)	

OPERATIONAL DATA	
Description of Operation	**Data**
Surface preparation time (min./hr.)	
Powder coating time (min./hr.)	
Heat curing time (min./hr.)	
Heat curing temperature ($^oC/^oF$)	

Comments—Describe the effectiveness of the following:

NILFISK equipment:_____

Nordson manual power outfit (coating application): _____

Eastwood infrared light cure system:_____

Powder coating inspection test kit:_____

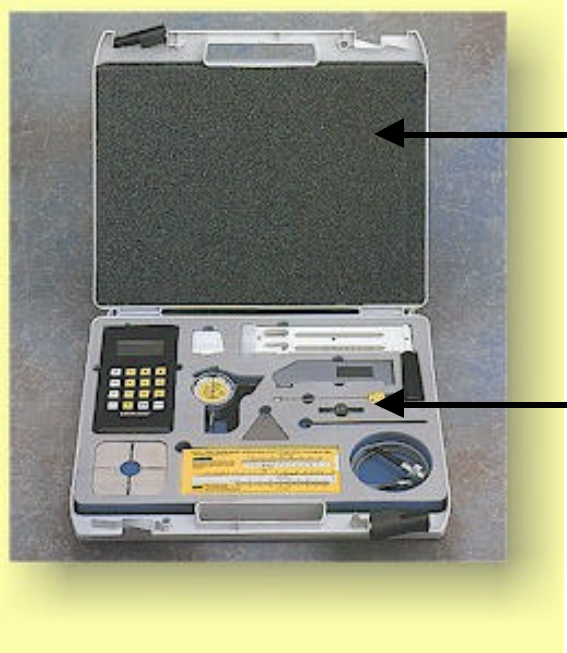
TABLE 3
CALENDAR
Month/Year: _____

1 **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload	**2** **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload	**3** **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload	**4** **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload	**5** **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload	**6** **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload	**7** **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload
8 **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload	**9** **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload	**10** **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload	**11** **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload	**12** **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload	**13** **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload	**14** **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload
15 **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload	**16** **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Work Performed	**17** **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload	**18** **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload	**19** **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload	**20** **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload	**21** **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload
22 **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload	**23** **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload	**24** **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload	**25** **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload	**26** **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload	**27** **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload	**28** **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload
29 **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload	**30** **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload	**31** **Circle one response to each question:** Was equip. used? Y N If not, why? Repair, Maintenance, No Workload				

WASTE GENERATED			
Date of Disposal	**Weight of Filter Bag**	**Date of Disposal**	**Weight of Filter Bag**

Comments: _____

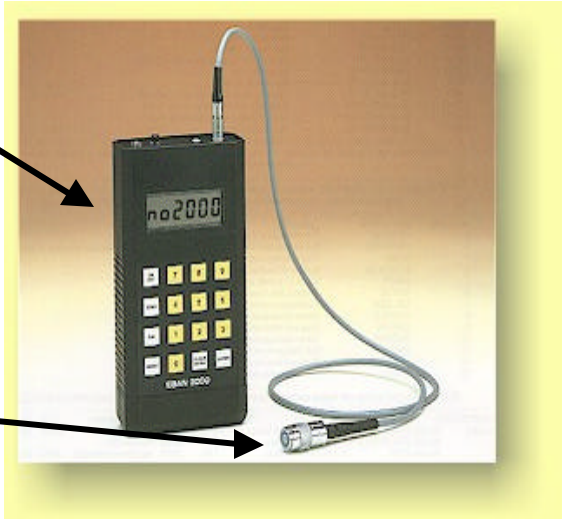
APPENDIX
PAINT INSPECTOR'S KIT



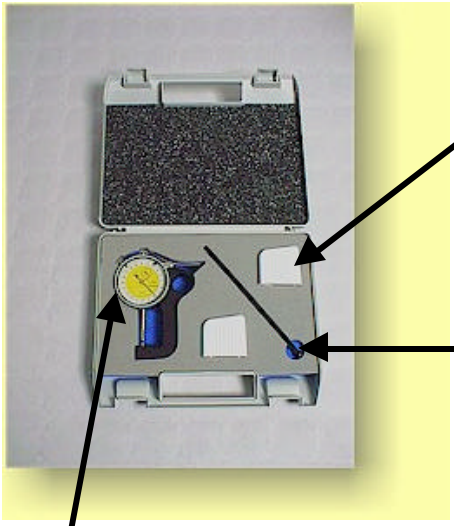
Paint Inspector's Kit [Part No. K1030]: This is a carrying case that includes the following equipment.

Calibration Foil [Part No. F1002]: The calibration foil is supplied with the EBAN3000(F) for calibration of the EBAN3000(F).

EBAN3000(F) [Part No. C3000]: This modular instrument has a touch pad that displays readings and is supplied with a measuring probe, calibration foil, battery, and



Measuring Probe [Included with EBAN3000]: The measuring probe is attached to the EBAN3000(F) and is used to measure the surface of the substrate. This measurement is then displayed on the EBAN3000(F).

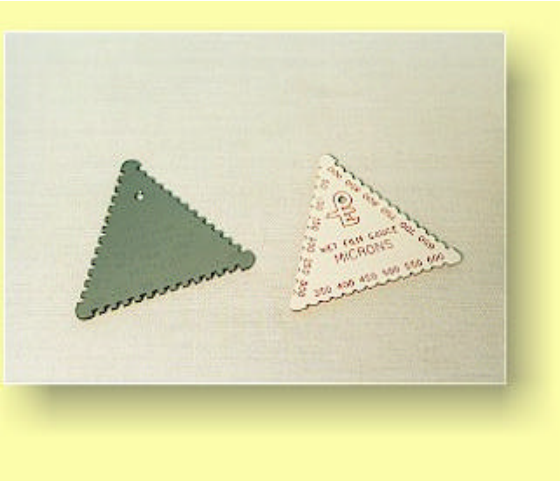


Testex Tape Roll [Part No. R1002]: The Testex tape, along with the brushing tool and the Testex snap gauge, is used to measure the surface profile of the piece. The Testex tape is used to make surface replicas and to obtain the minimum peak-to-valley reading to determine the actual surface profile.

Burnishing Tool [Part No. R1003]: The burnishing tool is used on the Testex tape. When moderate pressure is applied to the tape, it turns to a gray-colored circle. At this point, a replica of the rough surface is made and can be measured with the Testex snap gauge.

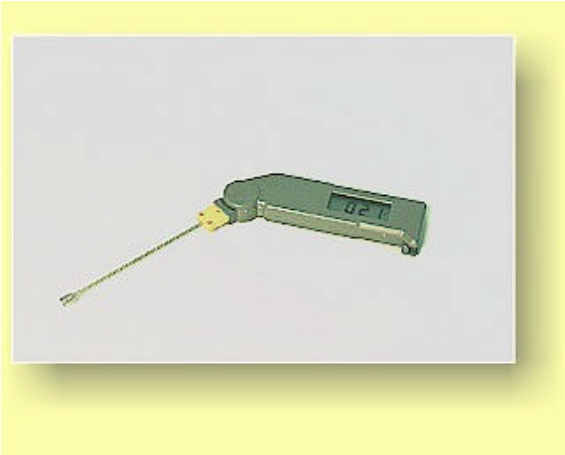
Testex Snap Gauge [Part No. R1004]: The Testex snap gauge is the final piece of equipment used to determine the surface profile. By placing the Testex tape between the anvils and gently lowering the moveable anvil onto the film near the center of the replica, an accurate reading can be measured. This measurement is used to obtain the average peak-to-valley height of the surface profile.

Steel Zero Plate [Part No. Z1001]: The steel zero plate is used in conjunction with the calibration foils to properly calibrate the EBAN3000(F). It is stored under the EBAN3000(F).

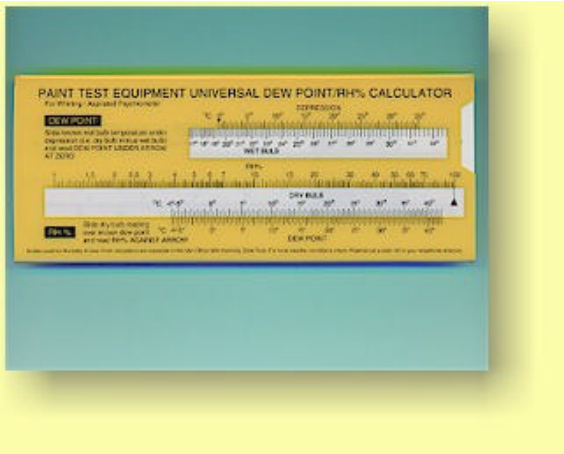


Wet Film Gauge [Part No. W1002]: The triangularly shaped wet film gauge measures wet paint film thickness when it is applied to newly coated substrate. This instrument is not used for powder coating operations.

Digital Thermometer [Part No. T1002]: The digital thermometer measures air and substrate temperatures. Its range is from 50ºC to 850ºC.



BS Whirling Hygrometer [Part No. H1001]: The whirling hygrometer is used to find temperature and moisture content prior to coating.



Dew Point and RH% Slide Calculator [Part No. H1002]: This is an accurate slide calculator that allows dew point in ºC and RH% to be calculated from the wet/dry bulb of the whirling hygrometer.

ISO Surface Roughness Comparator [Part No. R1006G]: The surface roughness comparator is a precision nickel comparator plate that meets International Standard ISO:8503 for grit/shortblast surface roughness comparison measurement.